DOCUMENT RESUME

ED 448 734 IR 020 497

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TITLE SMILE Maker: A Web-Based Tool for Problem Solving.

PUB DATE 1999-10-00

NOTE 7p.; In: WebNet 99 World Conference on the WWW and Internet Proceedings (Honolulu, Hawaii, October 24-30, 1999); see IR 020 454.

PUB TYPE Reports - Descriptive (141) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS Aptitude Treatment Interaction; Computer Uses in Education; *Concept Mapping; Constructivism (Learning); Higher Education; *Instructional Design; Locus of Control; Models; *Problem Solving; *World Wide Web

IDENTIFIERS *Learning Environments

ABSTRACT

This paper focuses on the purposes, theoretical model, and functionality of the SMILE (Solution Mapping Intelligent Learning Environment) Maker--a World Wide Web-based problem-solving tool. From an instructional design point of view, an attempt to establish a balance between constructivism/instructivism, content-treatment interaction/aptitude-treatment interaction, and user locus of control/system locus of control is made. The model behind the SMILE Maker consists of four sub-models (user, content, instructional events, and facilitator), each built from four components. A new concept mapping method that has been developed and experimentally validated is described. Four instructional scenarios--ready-made, tailor-made, self-made, and atelier--are discussed. (Contains 14 references.) (Author/MES)

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ED 448 734

SMILE Maker: A Web-Based Tool for Problem Solving

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Abstract: This paper focuses on the purposes, theoretical model and functionality of the SMILE Maker - a web-based problem-solving tool. From instructional design point of view, an attempt to established a balance between constructivism/ instructivism, content-treatment interaction/aptitude-treatment interaction, and user locus of control/system locus of control has been made. The model behind the SMILE Maker consists of four sub-models: user, content, instructional events and facilitator as each of them is being built up from four components. A new concept mapping method has been developed and experimentally validated. Four instructional scenarios are being discussed.

Introduction

The SMILE Maker is aimed at assisting people in perceiving, analysing and organising information when ill-structured problems occurs. SMILE stands for Solution Mapping Intelligent Learning Environment. SMILE Maker as a problem-solving tool is a synergy between mapping approaches and creative problem solving techniques. As a learning tool the attention has been paid on optimising the way users learn how to use this tool. From a functional perspective SMILE Maker implies a multi-agent approach to provide intelligent and efficient system-user interaction. The current version of SMILE Maker implemented in Java is a portable and platform independent tool.

In this paper concept mapping has been mentioned in two aspect: as a problem solving technique and as an ontological formalism describing the behaviour of an intelligent agent-based facilitator. Concept mapping is being considered also as a generic term standing for all mapping approaches - classical concept mapping, mind mapping, cognitive mapping, flowscaping, etc. Concept mapping has been defined as a knowledge representation graphical technique that uses a very simple conventional means of nodes, links and labels on the links to explore a problem solving space. However, knowledge representation is rather narrow predicate to express these phenomena. Concept mapping might be defined as a cognitive, affective, meta-cognitive, synergetic, and problem solving tool [Stoyanov 1999]. These functions of concept mapping are complementary to each other, as problem solving is the most subsuming category. The effectiveness of concept mapping as a problem-solving tool depends on the effectiveness of concept mapping as cognitive, an affective, a meta-cognitive, and as a synergetic tool.

Concept mapping is a *cognitive* and *affective* tool. Concept mapping is one of very few if not single graphical techniques that represents the way human mind organises information in problem solving. Moreover, concept mapping is an external extension of the cognitive and affective structures of personality. It enlarges, for example, the natural limited capacity of working memory. That reduces cognitive overload, improves the quality of problem solving production and enhances the speed of the ideational processes.

Concept Mapping is a *meta-cognitive* tool. It externalises cognitive processes and structures when problem solving occurs. Concept mapping stimulates self-appraisal (self-reflection), and self-management (control and monitoring), giving a sense of distance and ownership.

Concept mapping is a *synergetic* tool. It enables all psychological processes (attention, perception, memory, thinking, and language) to be involved (*process synergetic*). Attention directs perception, perception frees up memory, and memory makes reasoning processes more easy and flexible. Concept mapping integrates two kinds of coding - verbal and visual (*code synergetic*). The technique capitalises on the advantages of graphical representations without losing the flexibility and the power of natural language system. Concept

IR020497

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mapping provides a whole picture of problem solving space and shows the relationships between components (*product synergetic*).

Concept mapping is a *problem-solving* tool. It is not only information representation technique (*information collection tool*), but it is also idea generation (*divergence tool*) idea selection (*convergence tool*) and idea implementation technique (*planning tool*). Concept mapping communicates very well with creative problem solving techniques and supports the generation of unusual problem solutions (*lateral tool*).

Most of the mapping approaches are founded on a particular theory. Classical concept mapping approach is based on assimilation theory [Aussubel 1978; Novak & Gowin 1984]. Mind mapping [Buzan 1996] is associated with radial thinking theory. Flowscaping is grounded on the lateral thinking theory [De Bono 1994], and cognitive mapping interprets the Kelly's personal construct theory [Kelly 1955; Eden et al. 1995].

Some special software applications for concept mapping have been made available in order to improve the effectiveness and efficiency of concept mapping technique in a problem solving. Thus, Decision Explorer software supports cognitive mapping, MindMan uses mind mapping strategy, Inspiration is appropriate for applying the classical concept mapping conventions in problem solving

SMILE Maker differs essentially from above mentioned otherwise very attractive tools in two points:

- SMILE Maker is web-based tool.
- SMILE Maker supports the synergy between problem solving and learning.
- SMILE Maker uses an agent-based approach in order to realise a user-friendly and efficient human-system interaction.

SMILE Maker Rational

There are some theoretical trends SMILE Maker is based upon:

- SMILE Maker is both an individual and a group tool. There is a special component, called 'Partner' where all group activities are accumulated.
- SMILE Maker is both a content-treatment interaction and an aptitude treatment interaction tool. The tool proposes a new concept mapping method as a content to be acquired. It is also sensitive to the individual preferences in learning and problem solving.
- SMILE Maker is both external and internal locus of control tool. At the one extreme of this continuum are people that prefer to be guided (external locus of control) and at the other pole are persons who want to construct their own learning environment (internal locus of control).
- SMILE Maker is designed on the basis of the 4-AID generic agent-based model [Kommers, Aroyo, & Stoyanov 1999]. It consists of *four* sub-models: content, instructional events, user and intelligent agent-based facilitator.

Content sub-model is about a new concept mapping method. It includes *four* units: map information collection, map idea generation, map idea selection, and map idea implementation. Each map can be identified by purpose and particular components, supported by some specific creative problem solving techniques.

Map information collection is purposed to assemble all available information in problem space. The problem solving environment is explored in the terms of scientific facts, statistical data, personal experience, assumptions, metaphors and analogies, feelings, etc. Map idea generation is aimed at generating as many problem solutions as possible. With the map idea generation problem solving space is explored in the terms of ready-made solutions, suggestions, elaboration, unusual or "crazy ideas". Map idea selection purposely has to find the best candidate among the alternatives. The objective of map idea implementation is to operationalise a problem solution in the terms of sequence of activities and events, to present the needed steps in order to put solutions into practice.

Learner sub-model is defined by *four* learning styles: activist, reflector, theorist and pragmatist [Honey & Mumford 1992]. The large-scale complexity of the instructional strategies might be reduced to a representative sample of *four* instructional events: explanation, example, procedure, and practice. Each learning style manifests the subject's preferences to one of the instructional events. Theorist is very likely to choose an explanation. Reflector should look for an example. Pragmatic should start with procedure, and activist should go directly to the practice.

Agent-Based Support Layer

The Facilitator - an agent-based component, provides flexible and user-oriented assistance to the user in learning and problem solving. Many different roles are delegated to a number of agents, which in combination produce the behaviour of the facilitator as a user instructional designer, user navigator, system processes co-ordinator and adaptive content provider.

From a methodological point of view, the behaviour of the facilitator is premised upon the assumption that everybody has a potential to be complex and flexible in problem solving. From an ontological point of view, the behaviour of facilitator is formalised as a master concept map containing all components of content and instructional events in declarative knowledge format. This way the complexity in reasoning and extensive knowledge processing is simplified to reactive agent behaviour based on concept mapping formalism [Aroyo & Dicheva 1998]. A particular combination of Content units and Instructional Events constitutes a user's map. The facilitator identifies the gaps between the master map and a user's map and reacts according to specific production rules. One of the most important principles is that the cycle of Content units and the cycle of Instructional Events have to be completed. Thus, the facilitator creates more versatile problem solving style capitalising on the strong points of a particular style and minimising its weak points.

From a functional point of view the facilitator works on the basis of multi-agent layer within the architecture of the SMILE Maker tool. The multi-agent paradigm provides means to characterise processes, which occur in different modules of the system that is responsible for their performance. It creates an advantage for the facilitator - system instructional designer - to act as a reasoning and knowledge-based component not explicitly presented at the user interface. The users get only the result of its decision processes.

The modelling and the design of the facilitator layer is based on compositional development method for multi-agents systems called DESIRE and implemented in the AI department of Vrije Universiteit, Amsterdam. DESIRE stands for DEsign and Specification of Interacting REasoning components [Brazier, Jonker, Treur 1999]. This way both external and internal agent functionality are explicitly defined. The internal agent functionality concerns the expertise (knowledge requirements and reasoning capabilities) for performing domain tasks for which the agent is responsible. The external agent functionality concerns the social abilities in terms of co-ordination, guidance, co-operation and other forms of social behaviour.

In Figure 1 processes and architecture components are presented within the framework of the multi-agent support layer. Result of their activities is presented as behaviour of the system facilitator within the four scenarios described. It is a generic architecture, which supports process interaction and co-ordination in the frame of a user request and the adaptable system support provision described above. Some details and examples of facilitator's behaviour are also added later in the paper.

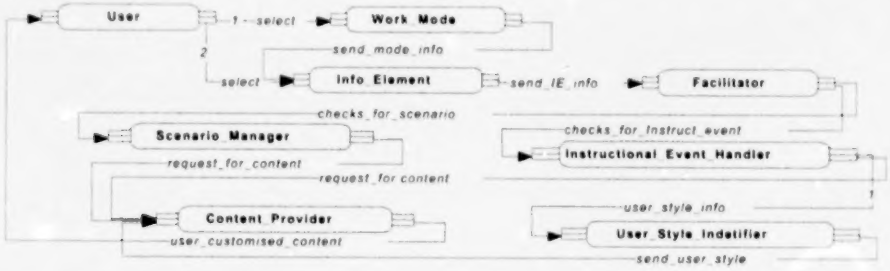

Figure 1: Compositional design of multi-agent support layer.

New Concept Mapping Method Validation

Two steps were undertaken in order to validate the new concept mapping method and to make it legitimate for the SMILE Maker. At first, a new concept mapping method was proposed as a tutorial in the framework of Ed-Media & Telecom conference [Kommers & Stoyanov 1998] and as a workshop during the conference Information Technologies and Programming [Kommers & Stoyanov 1998]. The purpose was to catch

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the strong and the weak points of the methodology and to take a general impression of how the people perceive the method. The audience attended these events expressed positive attitudes to the method.

Secondly, an experiment was conducted to get more strong evidence supporting the assumption that the new concept mapping method is an effective and efficient tool for problem solving [Stoyanov 1999]. The experimental design was factorial including as first independent variable concept mapping method with two levels: the traditional and the new one. The second independent variable was learning styles with two levels - doers and thinkers. The dependent variable was concept mapping production. 32 students from Faculty of Mathematics and Computer Science at University of Sofia were randomly selected and then randomly assigned to the experimental and the control groups according to their learning styles. The experimental group was trained in the new concept mapping method, and the control group was treated in the traditional method. Then the subjects were asked to solve a case.

The new concept mapping method proved to be more effective from the classical one as a significant difference was found on the main criteria such as broad perception, divergence, convergence and planning.

SMILE Maker Functionality Description

At the top level, SMILE Maker presents several functional components available for the user: Introduction, Guide, Resources and Scenarios. 'Introduction' provides with general information what the SMILE Maker tool is about. 'Guide' gives hints as how to navigate in the site. Apart from this general remarks each page has navigational tips with more specific information. 'Resources' contains opportunities to select some available concept mapping software for problem solving, to choose some creative problem solving techniques, to see some templates taken from a broad scope of subject dômains, and to make a search in a gallery of stored maps. Although these variables are very important, in this paper we will focus on the 'Scenarios' component. A special attention will be paid also to the group work mode called 'Partner'.

Learning Scenarios

There are four types of scenarios: Ready-made, Tailor-made, Self-made, and Atelier. 'Content' and 'Instructional Events' are parts of each scenario but they are treated in a different way.

Ready-made Scenario

Ready-made scenario is purposed for the people who like to be guided. The 'Content' units are considered in predetermined order starting with 'Map information collection' and finishing with 'Map idea implementation'. The order of 'Instructional Events' is also fixed. 'Explanation' is the first and 'Practice' is the last one. A user might start with map information collection and than each page is associated with particular instructional events. When a user enters the 'Practice' a graphical editor is opened automatically and he/she could apply what has been learned.

Tailor-made Scenario

'Tailor-made' scenario is challenged to provide an instruction according to the learning preferences. The locus of control is still on the system in respect to content providing, but it gives more freedom for an instructional event selection. This scenario is designed for the users that prefer to be leaded but the instructional path is predefined according to their learning preferences. Thus, a user gets the opportunity to identify him/herself as one of learning style and than follows a specific pattern. The patterns are 'Explanation', 'Example', 'Procedure' and 'Practice'. The source of variation is only 'Instructional Events'. The four user types are included as a common knowledge of the multi-agent system and this provides facilitator with the reactivity to the initial user's selection of an instructional event.

What makes differences from the first scenario in respect to 'Instructional Events' is that each path (pattern) is self-contained. It is dominated by one of the instructional events, but also includes pieces from other

instructional events. For instance, the 'Explanation' pattern includes some 'Examples' and gives some 'Procedures' before suggesting the 'Practice'.

Self-made Scenario

The sources of variation in the 'Self-made ' scenario are both 'Content' and 'Instructional Events'. There is not predefined sequence of problem solving maps. However, the content is still SMILE concept mapping method. The user can start picking up any of the maps and then select any of the instructional events. The assumption is that the user selects a specific option because of need to perform specific actions. When a user chooses 'Map idea selection' simultaneously with an introduction to this kind of map, a pop-up message from the facilitator appears on the screen providing with some advises. The facilitator reacts also when a user skips some of the 'Instructional Events' and goes directly to the 'Practice'.

SMILE Maker
Solution, Mapping, Intelligent, Learning,
Introduction | Guide | Scenarios
Scenarios
Ready-Made
Tailor-Made
Self-Made
Collection
Generation
Selection
Implementation
Atelier
Idea Selection Map
The purpose of Map Idea Selection
best candidate among the list of alternatives
already produced in the stage of Map Idea
Generation. You will hopefuly get some support
with number of useful techniques in your decision
making.
You will be able to learn what and how to do it
with Map Idea Selection using the learning events
of Explanation, Examples, Procedures and
Practice. Explanation gives theoretical
principles, background and assumptions behind
idea selection. The learning event of Examples
provides with some cases and templates of
selection techniques. Procedure explains in the
Facilitator's message: Netscape
May be this is important for you...
Idea Selection - probably that is what you
mostly need at the moment But it might be a
good idea before taking Map Idea
Selection to go fist to Map Information
Collection and than to Map Idea Generation
Idea selection is based on idea generation
Information collection gives ground for
effective idea generation
Collection ?
Close
Explanation
Example
Procedure
Practice
Document: Done
Start
SMILE Maker - Netscape
Facilitator's message
09:54

Figure 2: Screen-shot of self-made scenario

Atelier Scenario

'Atelier ' scenario is presupposed to serve for people who are self-confident in building up an own concept mapping approach. There are several components which a user could select from: Ideas, Maps, Templates, Method, and Practice. 'Ideas' stands for creative problem solving techniques. 'Maps' presents some mapping approaches like concept mapping, cognitive mapping, mind mapping, and flowscaping. 'Templates' presents some examples of combinations between mapping approaches and problem solving techniques. 'Practice' provides a graphical editor for maps drawing. 'Method' proposes the new concept mapping approach with four problem solving maps to be drawn. If a user selects this scenario and then goes to the practice, the facilitator reacts with a suggestion to her or him to have a look at other options such as Ideas, Maps and Templates in order to construct more effective strategy.

Group-work Mode - 'Partner'

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There are three different sub-modes of collaborative work in the 'Partner': exchanging of individually produced maps (Pin Sub-Mode), creating a common map within shared workspace (Brainstorming Sub-Mode) and moderating the group consensus through collecting, creating and sharing maps (Delphi Sub-Mode). With the first sub-mode, users take benefits getting some insights when looking at others' maps. The second sub-mode is an on-line collaborative work. A group solves a problem, making a common map(s) on the shared workspace. The SMILE Maker facilitates the group composition, interaction and work regulations. Different group problem solving techniques are available as well. With the third sub-mode a group member or the tutor could take the role of moderator. Individuals or small groups produce their concept maps solutions of a problem and than send them to the moderator. The moderator draws an adjusted map containing the main features of the individually produced maps. Then she/he sends it back to the group members that initiate a new stage of problem solution until a consensus is reached.

There are three main options available in 'Partner'. "Send a map" automatically opens e-mail box for sending individually produced map or a sequence of maps to another user, or to the moderator. "Gallery" gives an access to a pool of concept maps, created by other users, sorted by content (topic) or the type of map. The process of problem solving and the final map products are visible. SMILE Maker provides the option of saving several steps of maps' production and presenting them as a sequence on user request. When user initiates a problem solving, she/he could use "Gallery" to search for similar problems and models of solutions.

"Shared workspace" offers several options: group composition, techniques, rules, communication, and history. 'Group composition' gives some hints on the group size and homogeneity/heterogeneity in the terms of level of expertise, personal style and professional status. 'Techniques' provides information about group creative problem solving techniques. 'Rules' are about conventions of participation, self-presentation, timing, steps and procedures in creative problem solving techniques, some restrictions as well. 'Communication' supports a user to specify topic, objectives, rules, and techniques, to use some facilities such as a chat and to make an evaluation. 'History' saves not only the final concept mapping production but also the steps in creating a map(s).

"Shared Workspace" is based on Java Shared Object metaphor. Each common or shared map is composed of several linked-shared objects. A master copy of such a map is stored on the central server and this copy is replicated to all clients in a single collaborative session. When the user makes some changes in the nodes, links and labels within a common map these changes become immediately visible to all users.

References

1. Aroyo, L. & Dicheva, D. (1998). Agents that Make Your Information Meaningful and Visible: An Agent-Based Visual Information Management System, *Proc. of the WebNet'98 Conference*, AACE, Orlando, USA.
2. Aussubel, D., J. Novak, & H. Hanesian (1978). *Educational Psychology*. A Cognitive View. N.Y: Holt, Rinehart and Winston.
3. Brazier, F., Jonker, C., Treur, J. & Wijngaards, N.J.E. (1998). Compositional design of a Generic Design Agent. In: G. Luger, L. Interrante (eds.), *Proc. of the AAAI Workshop on Artificial Intelligence and Manufacturing: State of the Art and State of the Practice*, AAAI Press.
4. Buzan, T. (1996) *The Mind Map*. Book. N.Y: Plume.
5. De Bono, E. (1994) *Water Logic*, London: Penguin Books.
6. Eden, C.L., F. Ackerman & Cropper (1995). *Getting Started with Cognitive Mapping*. Supplied with Graphics COPE v2. Banxia Software, Glasgow.
7. Honey, P. & A. Mumford. (1992). *The Manual of Learning Styles*.
8. Kelly, G. (1955) *The Psychology of Personal Constructs*. New York: Norton.
9. Kommers, P., Aroyo, L. & Stoyanov, S. (1999). Agent-Based Instructional Design Model for Cognitive Mapping. *Proc. of the Ed-Media and Telecom'99 conference*, AACE, Seattle, USA, 482 - 488.
10. Kommers, P. & S. Stoyanov (1998) Concept Mapping: practical implications in meaningful context - a tutorial. *Ed-Media & Telecom'98 conference*, Freiburg, June 20-25.
11. Kommers, P. & S. Stoyanov (1998) Computer-Based Concept Mapping in Problem Solving Design - a workshop. *IT & P' 98 (Information Technology and Programming '98) conference*, Sofia, June 9-13.
12. Novak, J. D. Govin. (1984) *Learning How to Learn*. Cambridge: Cambridge University Press.
13. Stoyanov, S. (1997) Cognitive Mapping as a Learning Method in Hypermedia Design. *Journal of Interactive Learning Research*, vol. 8, No 3/4, 309 - 325.
14. Stoyanov, S. (1999). *Cognitive Mapping as a Learning Method in a Problem Solving Design*, Interim Report. Faculty of Educational Science and Technology, Department of Instrumentation, University of Twente.